PROC. BIOL. SOC. WASH.
99(3), 1986, pp. 472–477

EPIZOIC BARNACLES ON PLEURODIRAN TURTLES: IS THE RELATIONSHIP RARE?

J. G. Frazier

Abstract.—The occurrence of epizoic *Balanus improvisus* on a side-necked turtle in Argentina illustrates the southern extent of this barnacle's wide geographic range, and the diversity of habitats and substrates used. Preferred settling sites for epizoa are similar on all non-marine turtles described as hosts; barnacles concentrate on the posterior of the carapace. The present account of epizoa on a pleurodiran turtle raises questions as to whether the lack of records reflects a true lack of epizoic barnacle-Pleurodira relationships, or a lack of observations. Because the symbiotic relationship is dependent on the turtles' occurrence in estuarine habitats, a better understanding of pleurodiran distributions is needed. The little data there are suggest that recent Pleurodire turtles are generally restricted to fresh water, but a few species may inhabit saline waters and they are therefore likely to host epizoic barnacles.

Epizoic barnacles have been reported on few species of Testudines. There is an obligate relationship between several barnacles of the Chelonibiinae and half a dozen marine species in the families Cheloniidae and Dermochelyidae (Ross 1963a, b; Zullo and Bleakney 1966; Ross and Newman 1967; Ernst and Barbour 1972; Zullo 1979). In some populations of marine turtles chelonibiine infestations are common (Frazier, unpublished data).

At least five species of "freshwater" turtles (Chelydridae and Emydidae) have been reported to carry epizoic barnacles, but such reports are rare, for they evidently represent an opportunistic relationship. An adult male alligator snapping turtle, *Macroclemys temminckii* (Troost), near Mobile Bay, Alabama, had 43 *Balanus improvisus* Darwin, mostly on its posterior carapace (Jackson and Ross 1971b). The carapace of an adult male Alabama red-belly turtle, *Chrysemys* (=*Pseudemys*) *alabamensis* (Baur), also from Mobile Bay, Alabama, carried more than 600 *Balanus improvisus* (Jackson and Ross 1972), as well as Bryozoa (Jackson and Ross 1975). Carr (1940) mentioned barnacles being on several discarded shells of *Chrysemys concinna suwanniensis* (Carr) at Cedar Key, Florida. An adult female red-belly turtle, *Chrysemys r. rubriventris* (Le Conte), near the mouth of the Delaware River had 12 *Balanus improvisus* on the posterior of its carapace (Arndt 1975).

There are numerous records of epizoic barnacles on diamondback terrapins, *Malaclemys terrapin* (Schoepff), from eastern and western Florida. Ross and Jackson (1972) reported two *Balanus improvisus* attached to epizoic oysters (Jackson and Ross 1971a) that were on the posterior of the carapace, and two *Chelonibia patula* (Ranzani) that were on a posterior ventral marginal surface, of an adult female. Jackson et al. (1973) found a vacant *Balanus eburneus* Gould, occupied by a bivalve mollusk, on the posterior carapace of an adult female terrapin. Seigel (1983) has done the only detailed study on levels of infestation, reporting three species of epizoic barnacles on two populations of diamondback terrapins: *Chelonibia manati* Gruvel infested 47.9% of the total; *Balanus eburneus,* 42.4%; and *Chelonibia testudinaria* (L.), 9.5%.

Fig. 1. Oblique posterior view of *Hydromedusa tectifera* (JGF 4007) showing *Balanus* aff. *improvisus* (USNM 211283) and several white basal disks where barnacles were once affixed (tape in cm).

All of the above-mentioned turtles are members of the Cryptodira that either live in, or occasionally have contact with, marine environments. The only turtle of the suborder Pleurodira that has been previously recorded to host epizoic barnacles, is a matamata, *Chelus fimbriatus* (Schneider), that washed up on Trinidad (Boos in Pritchard and Trebbau 1984:97, 107, pl 31 F). The present note reports the occurrence of a wide ranging barnacle on the South American pleurodire *Hydromedusa tectifera,* and discusses the general phenomena of epizoic barnacles on pleurodires.

Materials and Methods

In August or September of 1982 a female side-necked turtle, *Hydromedusa tectifera* Cope (Pleurodira: Chelidae), was collected during the day while crossing route No. 11 (or No. 2) several kilometers west of the Bay of Samborombon, Province of Buenos Aires, Argentina (36°S, 57°W). On its carapace were about a dozen live barnacles. It was isolated from conspecifics in a freshwater tank in Villa Gessel, where the barnacles died shortly thereafter (R. Gessel, pers. comm.). On 11 March 1983 I measured and photographed the specimen (JGF 4007; Fig. 1). Collections of *H. tectifera* in Argentine museums in Buenos Aires and La Plata were examined for additional occurrences of epizoic barnacles.

Results and Discussion

The turtle's curved medial carapace length was 27 cm. It was evidently an adult in good health, for in January 1983, four to five months after capture, it laid seven or eight eggs. On the posterior half of the carapace

were two barnacle shells (external plates without any soft parts inside) and ten white basal disks where barnacles had once been affixed.

The barnacles were identified as *Balanus* sp. aff. *B. improvisus* Darwin. The larger specimen (USNM 211283) measured 5.0 mm in height and 12.0 mm in rostro-carinal diameter. Barnacles of the same species are common in the sublittoral of the southwestern Atlantic—notably in the Bay of Samborombon and in waters of low salinity several km from the Bay, where they often form dense encrustations on shallow water crabs (Bastida, pers. comm.; Botto, pers. comm.; pers. obs.).

Balanus improvisus is remarkable for occurring in waters of many subtropical and temperate seas (having been introduced into several regions by human activities) in depths from low tide to nearly 40 m (Darwin 1854, Pilsbry 1916, Bousfield 1954, Utinomi 1966, Carlton and Zullo 1969, Newman and Ross 1976). It has wide thermal and salinity tolerances, surviving extended periods in a variety of estuarine and marine conditions; substrates are known to include various inanimate objects and hard-shelled sessile and sedentary invertebrates (Bousfield 1955, Newman 1967, Gordon 1969, Gosner 1971, Carlton and Zullo 1969). *Balanus improvisus* has been recorded on more species of "freshwater" turtles than has any other barnacle (Jackson and Ross 1971b, 1972; Ross and Jackson 1972; Arndt 1975). Hence its occurrence on a side-necked turtle from an estuary in Argentina is consistent with the barnacle's known habits.

Several authors have estimated the ages of epizoic *Balanus improvisus* on the basis of growth data presented by Costlow and Bookhout (1957). The estimated relationships between size (rostro-carinal diameter) and age were: 4.6 to 10.4 mm—three to ten weeks old (Jackson and Ross 1971b); 1.0 to 10.2 mm—two days to ten weeks and older (Jackson and Ross 1972); and 4.3 to 9.9 mm—three to four months old. In this light, the 12 mm specimen from Samborombon may have lived for about three months on the *Hydromedusa tectifera.* The basal disks left by several other barnacles on this turtle were of comparable diameters, and probably of a similar age; some were smaller and probably younger.

Although the orientation of the barnacles on the *H. tectifera* was not determined, their concentration at the posterior of the carapace is consistent with reports of epizoic barnacles on other turtles, where water currents and food availability were thought to influence the site and orientation of attachment (Jackson and Ross 1972, Ross and Jackson 1972, Jackson et al. 1973, Arndt 1975, Seigel 1983). The posterior of the carapace apparently has the best conditions of water flow, while being a relatively protected site for the barnacles.

Affixing to a turtle is evidence for highly opportunistic settling behavior, which is well supported by the variety of substrates on which *Balanus improvisus* has been recorded. Since *B. improvisus* can withstand only about 24 hours of desiccation (Newman 1967), the survival of epizoan individuals is dependent on the behavior of the host. In the case of *H. tectifera,* there is probably little risk of extended terrestrial forays.

Pleurodiran turtles are generally regarded as restricted to freshwater habitats (Freiberg 1979, Pritchard 1979), but little is known of their salinity tolerances. Pritchard and Trebbau (1984) argued that the inability to cross, or survive, salt-water has been a major factor in shaping the distributions and evolution of pleurodiran turtles. Pritchard (1984) argued this point further, especially for the Chelidae, thus challenging the detailed phylogenetic studies of Gaffney (1977).

There are, however, several records of Pleurodires (including chelids) in salt-water. Broadley (in litt., 16 Nov 1984) has found "*Pelomedusa subrufa* in brackish water on the periphery of the Makgadigadi Pans, Bo-

tswana," and *Pelusios castaneus castanoides* within a few meters of the mangrove swamp on Inhaca Island, Mozambique. Bour (in litt., 22 Mar 1985) found *Pelusios subniger* in estuaries in Seychelles and Madagascar. Rhodin and Mittermeier (1976) reported *Chelodina siebenrocki* in "tidally-influenced coastal swamps" along southern New Guinea and on offshore islands. Cogger (in litt., 7 Jan 1985) reported "a number of records" of *Chelodina longicollis* from estuarine conditions in Australia. In addition, there is strong evidence that several fossil pleurodires (all of them pelomedusids) were marine, including *Stupendemys geographicus* (Wood), the world's largest turtle (Wood 1976:15).

Hydromedusa tectifera, common in freshwater systems where filamentous algae commonly cover the carapace, is previously unrecorded from saline waters, but E. Gudynas (pers. comm.) has records of this species swimming in Rio de la Plata as far seaward as Punta del Este, Uruguay, where conditions are nearly marine. The size of the epizoic barnacles reported herein illustrate that *H. tectifera* can survive estuarine conditions with no ill effects for at least several days—the time necessary for *B. improvisus* to settle, metamorphose and begin sessile growth (see Zullo et al. 1972). The record also represents a range extension for *Hydromedusa tectifera* at least as far south as the Bay of Samborombon; the next nearest southern record is La Plata, 150 km to the northwest (Frazier, in prep.).

No museum specimens with evidence of epizoic barnacles were found among the 30 specimens examined. However, epizoa are frequently removed to show better the morphological features of the host, and the rate of occurrence of epizoa on museum specimens probably does not reflect the natural situation.

The paucity of reports of epizoic relationships between pleurodiran turtles and barnacles could reflect a lack of observations. Although some cryptodiran populations are heavily infested (Seigel 1983), and several species serve as hosts, the epizoan phenomenon is poorly documented in this suborder also. There is no a priori reason why side-necked turtles in estuarine conditions in South America, Africa, and Australia should not carry epizoa. The question is: how many pleurodiran populations venture into estuarine conditions? Distributional data suggest that few pleurodiran turtles (except *Chelodina siebenrocki* and possibly also *Hydromedusa tectifera*) commonly occur outside of fresh water (e.g., Broadley 1981, in litt., 16 Nov 1984; Bour 1983; Pritchard and Trebbau 1984), but more detailed data are needed.

Acknowledgments

Dr. R. Gesell kindly allowed me to examine his specimens; and Dr. R. Bastida (Instituto Nacional de Investigacion y Desarrollo Pesquero), J. Botto (Museo Argentino de Ciencias Naturales "Bernadino Rivadavia"), B. Kensley (USNM) and W. A. Newman (Scripps Institute of Oceanography) examined the barnacles; they, together with R. Bour, D. G. Broadley, H. G. Cogger, C. Ernst and A. G. J. Rhodin, all provided valuable information; N. Frazer, R. W. McDiarmid, and W. A. Newman made valuable comments on earlier drafts, as did several reviewers. The Salas family kindly provided hospitality and transportation.

Literature Cited

Arndt, R. G. 1975. The occurrence of barnacles and algae on the red-bellied turtle, *Chrysemys r. rubriventris* (Le Conte).—Journal of Herpetology 9(4):357–359.

Bour, R. 1983. Trois populations endémiques du genre *Pelusios* (Reptilia, Chelonii, Pelomedusidae) aux îles Seychelles, relations avec les espèces africaines et Malgaches.—Bulletin du Muséum National d'Histoire Naturelle, ser. 4, 5A(1):343–382.

Bousfield, E. L. 1954. The distribution and spawning seasons of barnacles on the Atlantic coast of

Canada.—Bulletin of the National Museum of Canada 132:112–154.

———. 1955. Ecological control of the occurrence of barnacles in the Miramichi Estuary.—Bulletin of the National Museum of Canada 137:iii + 1–69.

Broadley, D. G. 1981. A review of the genus *Pelusios* Wagler in Southern Africa (Pleurodira: Pelomedusidae).—Occasional Papers of the National Museum of Rhodesia, ser. B 6(9):633–686.

Carlton, J. T., and V. A. Zullo. 1969. Early records of the barnacle *Balanus improvisus* Darwin from the Pacific coast of North America.—Occasional Papers of the California Academy of Sciences 75:1–6.

Carr, A. F., Jr. 1940. A contribution to the herpetology of Florida.—University of Florida Biological Science Series 3(1):1–118.

Costlow, J. D., and C. G. Bookhout. 1957. Body growth versus shell growth in *Balanus improvisus*.—Biological Bulletin 113(2):224–232.

Darwin, C. G. 1854. A monograph on the sub-class Cirripedia, with figures of all the species (the sessile species). The Ray Society, London, viii + 684 pp., 30 pls.

Ernst, C. H., and R. W. Barbour. 1972. Turtles of the United States. University Press of Kentucky, Lexington, x + 347 pp.

Freiberg, M. A. 1979. El mundo de las Tortugas (Third edition). Albatros, Buenos Aires, 151 pp.

Gaffney, E. S. 1977. The side-necked turtle family Chelidae: A theory of relationships using shared derived characters.—American Museum Novitates 2620:1–28.

Gordon, C. M. 1969. The apparent influence of salinity on the distribution of barnacle species in Chesapeake Bay (Cirripedia).—Crustaceana 16(2):139–142.

Gosner, K.L. 1971. Guide to identification of marine and estuarine invertebrates. John Wiley & Sons Inc., New York, 693 pp.

Jackson, C. G., Jr., and A. Ross. 1971a. Molluscan fouling of the ornate diamondback terrapin, *Malaclemys terrapin macrospilota* Hay.—Herpetologica 27(3):341–344.

———, and ———. 1971b. The occurrence of barnacles on the alligator snapping turtle, *Macroclemys temminckii* (Troost).—Journal of Herpetology 5(3–4):188–189.

———, and ———. 1972. Balanomorph barnacles on *Chrysemys alabamensis*.—Quarterly Journal of the Florida Academy of Sciences 35(4): 173–176.

———, and ———. 1975. Epizoic occurrence of a bryozoan, *Electra crustulenta*, on the turtle *Chrysemys alabamensis*.—Transactions of the American Microscopical Society 94(1):135–136.

———, ———, and G. L. Kennedy. 1973. Epifaunal invertebrates of the ornate diamondback terrapin *Malaclemys terrapin macrospilota*.—American Midland Naturalist 89(2):495–497.

Newman, W. A. 1967. On physiology and behavior of estuarine barnacles.—Proceedings of the Symposium on Crustacea, Marine Biological Association of India 3:1038–1066.

———, and A. Ross. 1976. Revision of the balanomorph barnacles; including a catalogue of the species.—San Diego Society of Natural History, Memoir 9:1–108.

Pilsbry, H. A. 1916. The sessile barnacles (Cirripedia) contained in the collections of the U.S. National Museum; including a monograph of the American species.—Bulletin of the United States National Museum 93:v + 366 p., 76 pls.

Pritchard, P. C. H. 1979. Encyclopedia of turtles. T. F.H., Neptune, New Jersey, 895 pp.

———. 1984. Piscivory in turtles and evolution of the Long-necked Chelidae.—Symposium of the Zoological Society of London, No. 52:87–110.

———, and T. Trebbau. 1984. The turtles of Venezuela.—Contributions to Herpetology 2:ix, 1–403, 47 pls, 16 maps.

Rhodin, A. G. J., and R. A. Mittermeier. 1976. *Chelodina parkeri*, a new species of chelid turtle from New Guinea, with discussion of *Chelodina siebenrocki* Werner, 1901.—Bulletin of the Museum of Comparative Zoology 147(11):465–488.

Ross, A. 1963a. A new Pleistocene *Platylepas* from Florida.—Quarterly Journal of the Florida Academy of Sciences 26(2):150–158.

———. 1963b. *Chelonibia* in the Neogene of Florida.—Quarterly Journal of the Florida Academy of Sciences 26(3):221–233.

———, and C. G. Jackson, Jr. 1972. Barnacle fouling of the ornate diamondback terrapin, *Malaclemys terrapin macrospilota*.—Crustaceana 22(2): 203–205.

———, and W. A. Newman. 1967. Eocene Balanidae of Florida, including a new genus and species with a unique plan of "turtle-barnacle" organization.—American Museum Novitates 2288: 1–21.

Seigel, R. A. 1983. Occurrence and effects of barnacle infestations on diamondback terrapins (*Malaclemys terrapin*).—American Midland Naturalist 109(1):34–39.

Utinomi, H. 1966. Recent immigration of two foreign barnacles into Japanese waters.—Proceedings of the Japanese Society of Systematic Zoology 2:36–39. [English abstract]

Wood, R. C. 1976. *Stupendemys geographicus*, the world's largest turtle.—Breviora Museum of Comparative Zoology 436:1–31.

Zullo, V. A. 1979. Thoracican Cirripedia of the Low-

er Pliocene Pancho Rico Formation, Salinas Valley, Monterey County.—Contributions in Science, Los Angeles County Museum of Natural History 303:1–13.

———, D. B. Beach, and J. T. Carlton. 1972. New barnacle records (Cirripedia, Thoracica).—Proceedings of the California Academy of Sciences, ser. 4, 39(6):65–74.

———, and J. S. Bleakney. 1966. The cirriped *Stomatolepas elegans* (Costa) on leatherback turtles from Nova Scotia waters.—Canadian Field Naturalist 80(3):162–165.

NHB W203, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.